

Ice Dolines on Larsen Ice Shelf, Antarctica: An Application of IKONOS Data

Dr. Robert Bindschadler

NASA

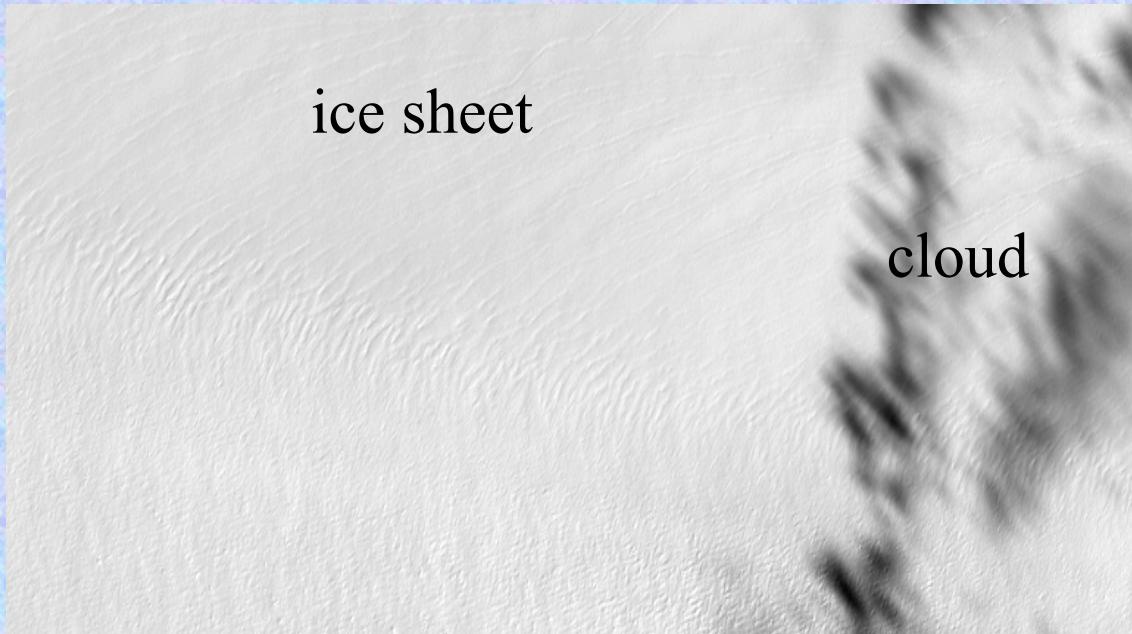
Goddard Space Flight Center

Outline

- Data selection
- Qualitative use
- Quantitative use

Data Selection

- Web page is great
- Cloud discrimination is not

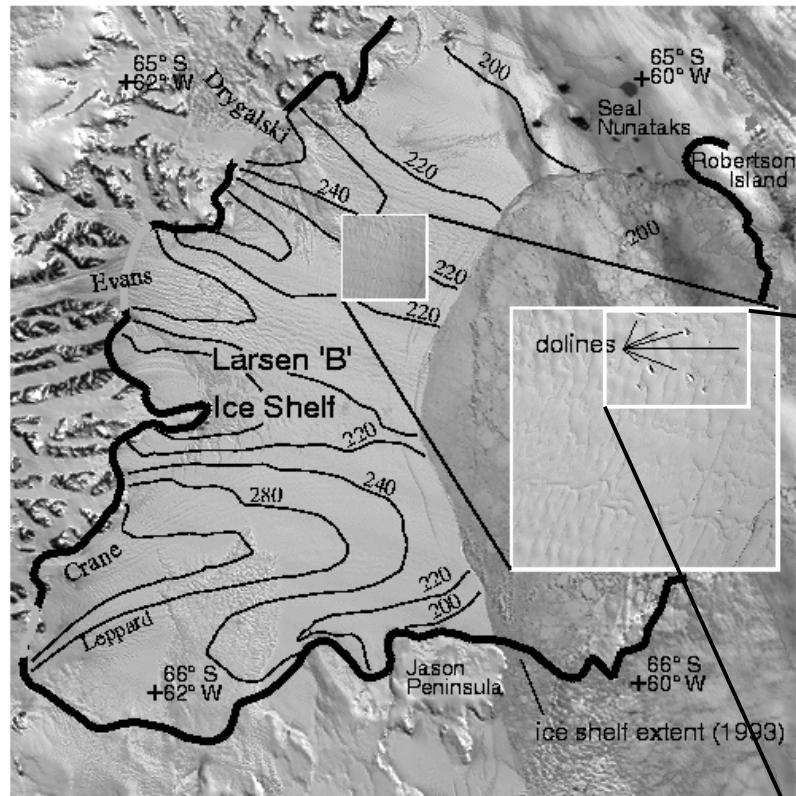


Task 625
January 6, 2001

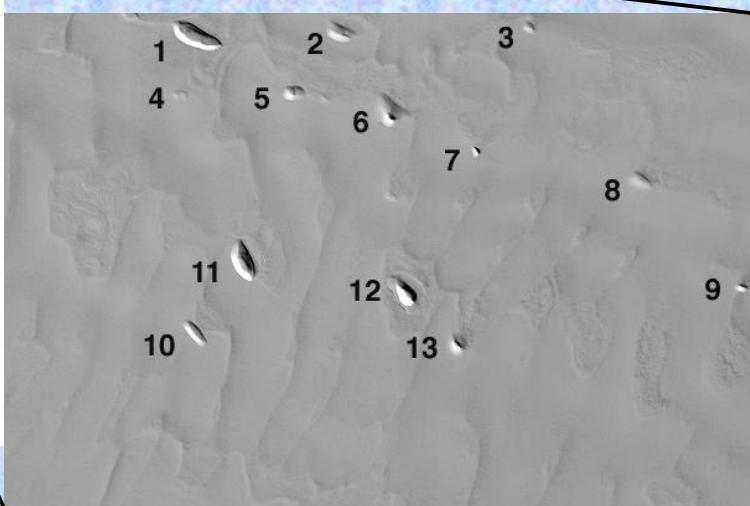
MCCA: 99%

Actual Cloud
Cover: <20%

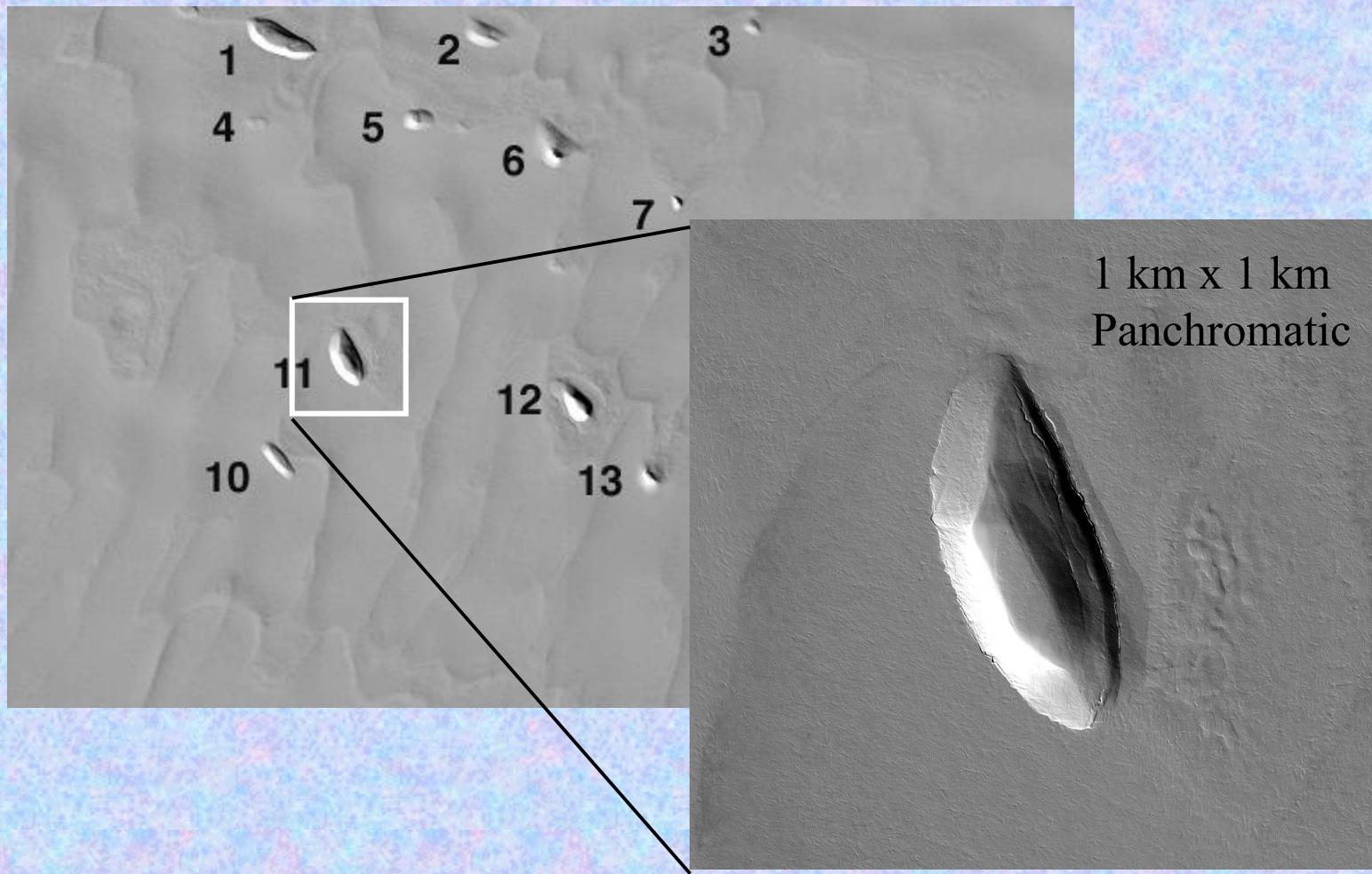
Qualitative Use



Ice Doline Field,
Larsen Ice Shelf,
Antarctica

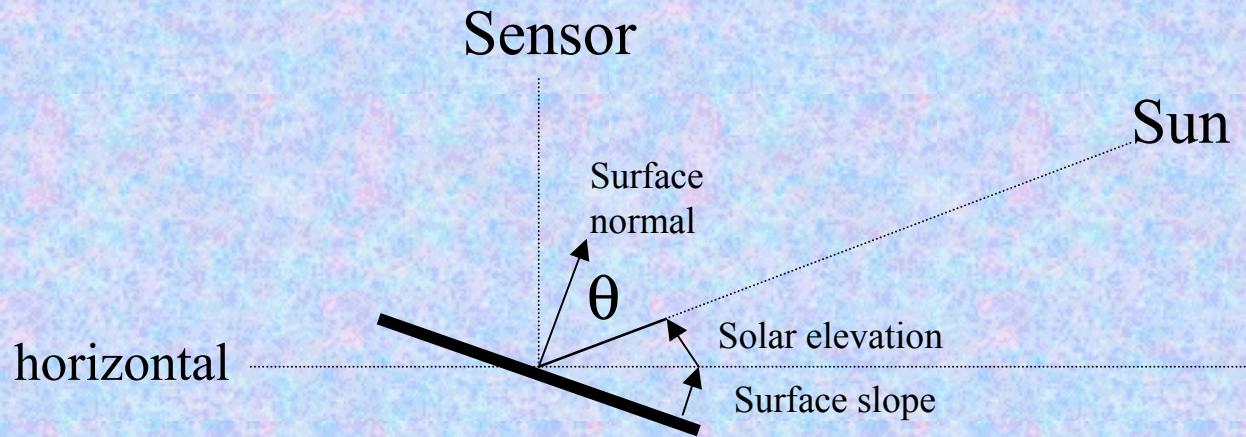


Stunning Detail!!



Quantitative Use

Photoclinometry - Conversion of image brightness to surface slope

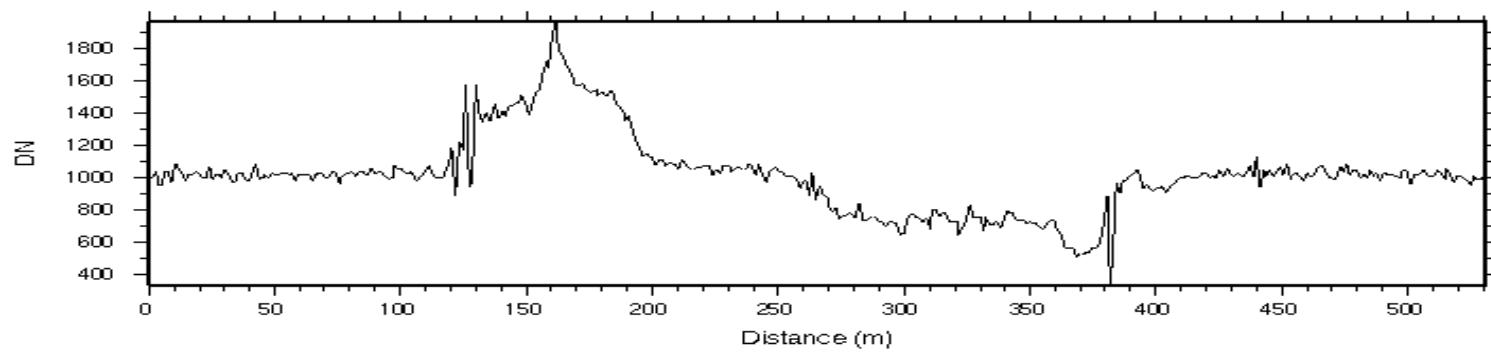
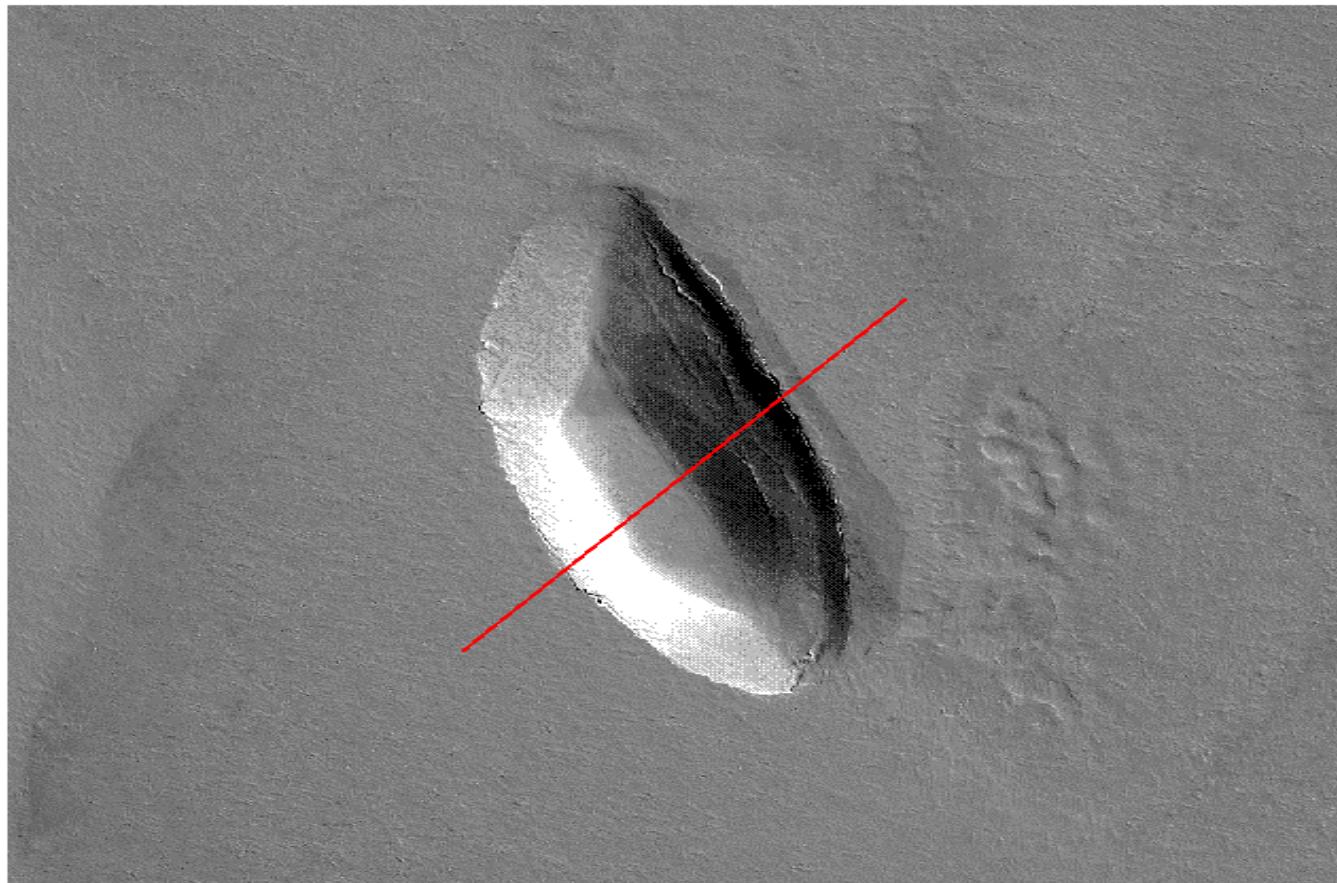


$$DN = \int_{\lambda} C T(\lambda) [I(\lambda) R \cos \theta - L_o(\lambda) + S(\lambda)] d\lambda$$

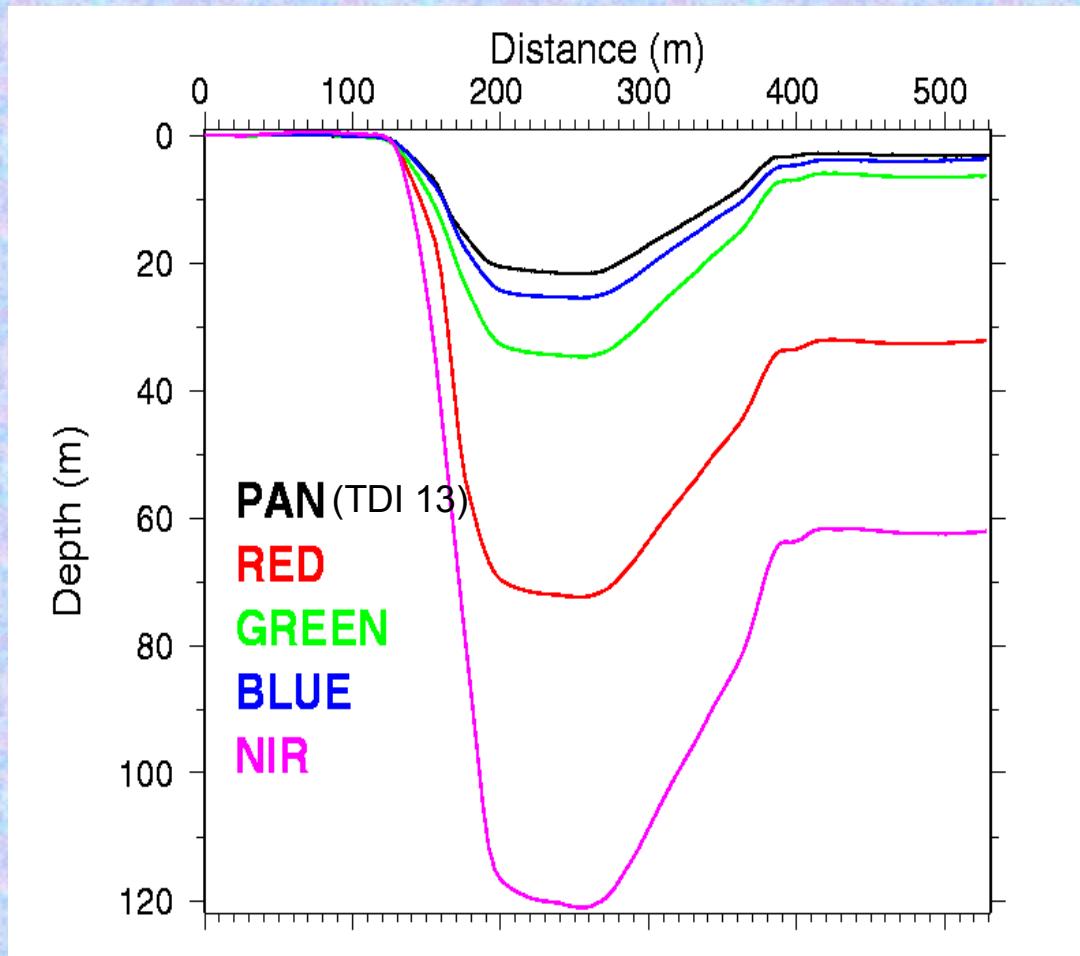
$$DN = CI_f R \cos \theta + B$$

- DN = image brightness
- C = calibration coefficient (converts radiance to DN)
- I_f = “bandpassed” solar irradiance
- R = “bandpassed” surface reflectance
- θ = illumination angle
- B = path radiance (scattering) and sensor radiance offset

#2: 1050m x 1000m



Using Space Imaging Parameters



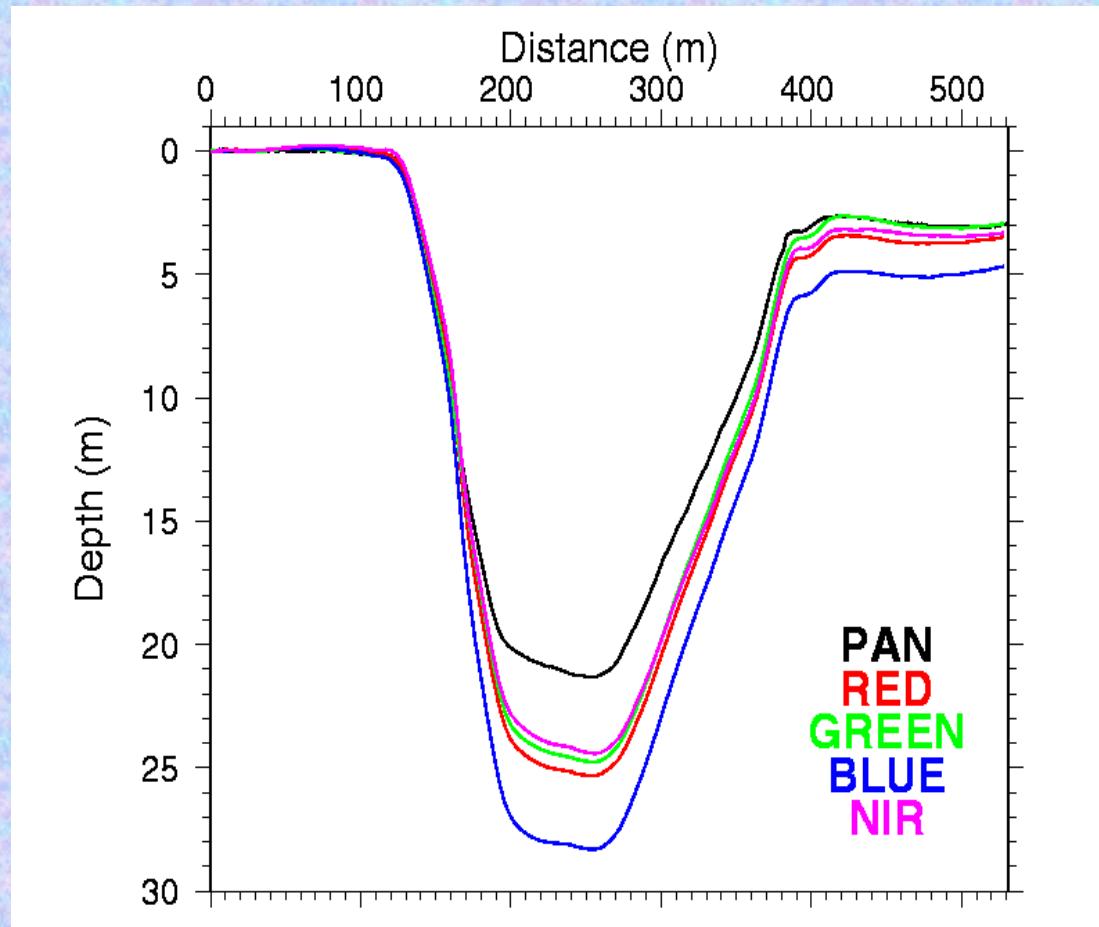
$$DN = CI_f R \cos \theta + B$$

B adjusted so mean DN
is horizontal surface

Results:

- B values
unreasonable
- Spectral bands
produce different
profiles
- Surface is sloped

Using ‘‘Dark Object’’ and ‘‘Flat Shelf’’



$$DN = CI_f R \cos \theta + B$$

B=119 (darkest pixel)

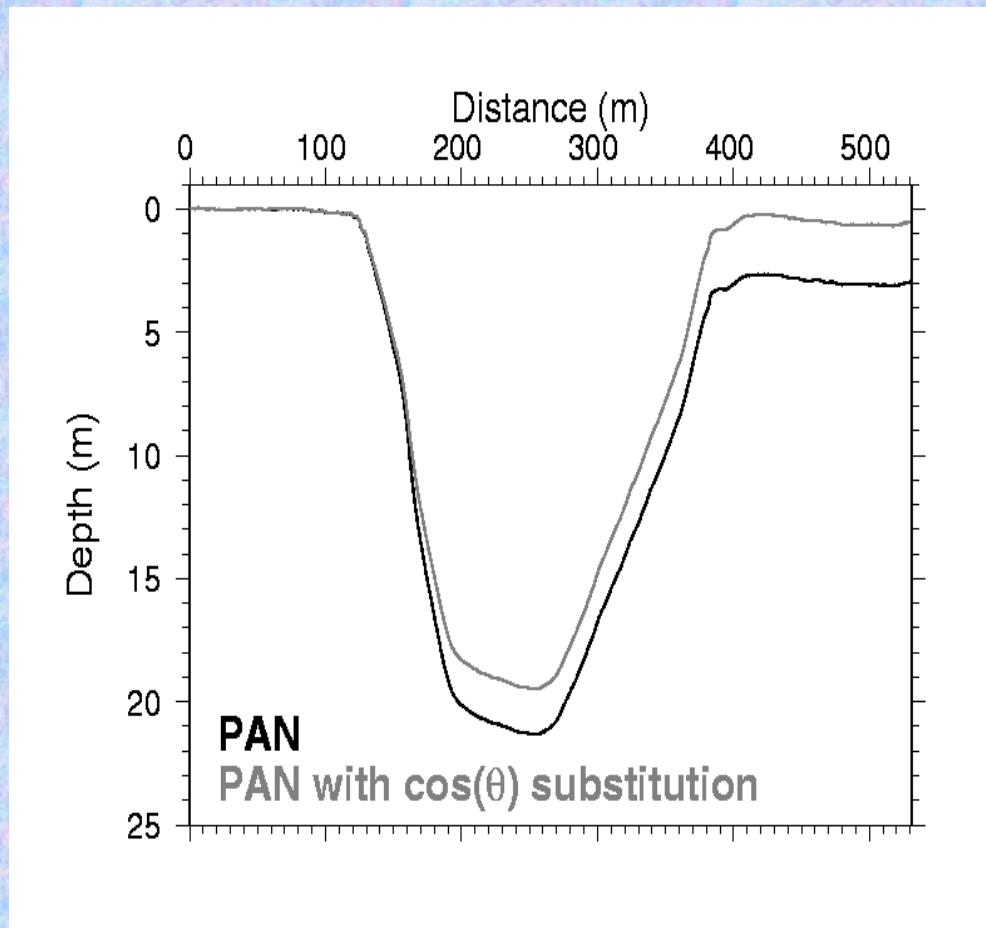
Flat ice shelf:

$$DN (\theta=65.5^\circ)=1004$$

Results:

- Depth is about right
- Surface still sloped

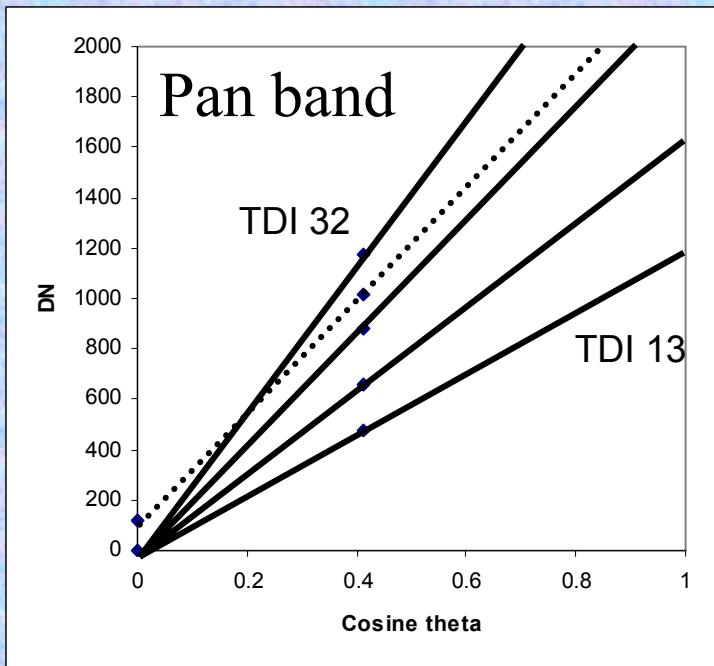
Sloped Surface Effect



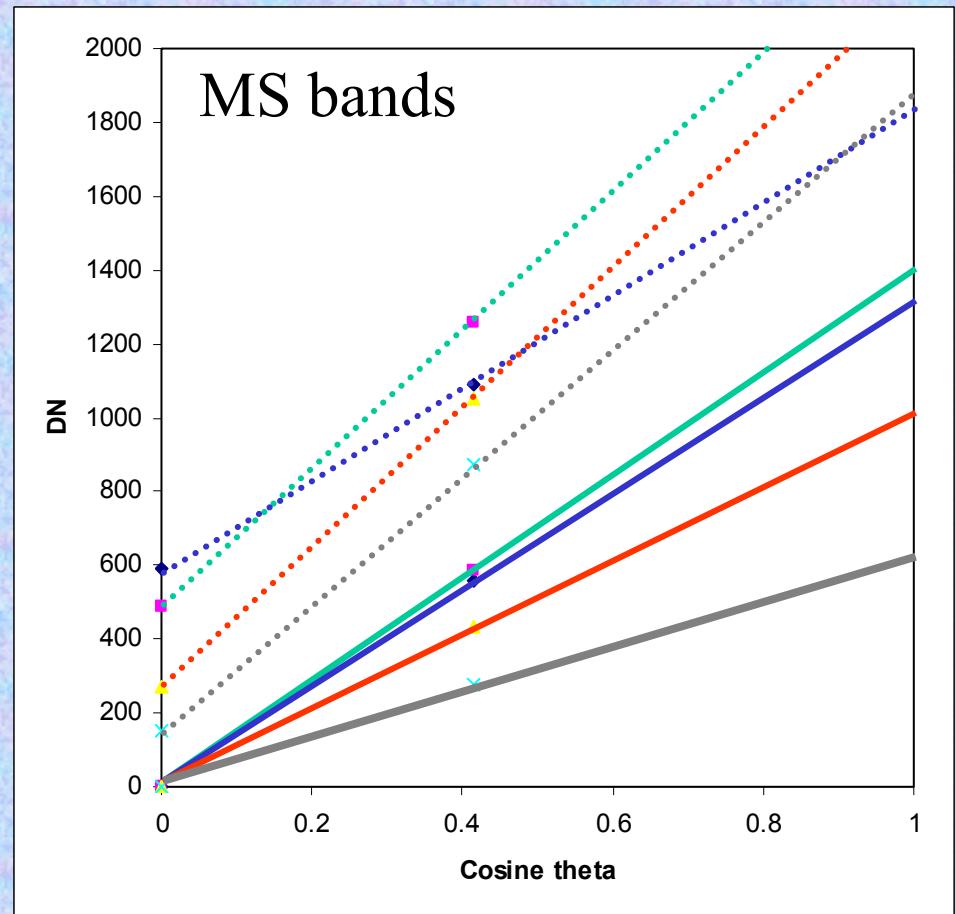
Could be due to:

- non-Lambertian reflectance (replace $\cos\theta$ with symmetric function)
- non-linear sensor response
- non-linear adjustment of data supplied to customer

Calibration Discrepancies

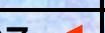


— Space Imaging parameters
········ Two-point method



Apparent Reflectance

$$DN = CI_f R \cos \theta + B$$

	<i>DN mean</i>	<i>I (W/m2)</i>	<i>B</i>	<i>C (DN/W/m2)</i>	<i>R Apparent</i>	<i>R Correct</i>
Pan (TDI-24)	1014	562	119	4.73	0.81	0.8
MS-1 (Blue)	1092	140	590	10.15	0.85	0.95
MS-2 (Green)	1255	167	489	9.11	1.22  0.93	0.93
MS-3 (Red)	1050	110	272	10.54	1.62  0.9	0.9
MS-4 (NIR)	873	110	151	8.06	1.97  0.75	0.75

Differences between last two columns indicates miscalibration

Please, Please, Please



with the data

“Wasted” Dynamic Range

	Dynamic Range W/m ²	DN Range	Sensitivity DN/W/m ²	Solar Irradiance W/m ²	Range/ Solar	Normalized Sensitivity
Pan (TDI-13)	741	1900	2.6	562	1.32	1441
Pan (TDI-32)	301	1900	6.3	562	0.54	3548
MS-1 (Blue)	187	1900	10.2	140	1.34	1422
MS-2 (Green)	209	1900	9.1	167	1.25	1518
MS-3 (Red)	180	1900	10.6	110	1.64	1161
MS-4 (NIR)	236	1900	8.1	110	2.15	886
AVHRR-ch1 *	329	982	3.0	338	0.97	1009
TM-band1 *	58	255	4.4	235	0.25	1033
TM-band4 *	183	255	1.4	302	0.61	421

* from Bindschadler and Vornberger (2000)

Conclusions

- IKONOS imagery are high quality
- Potential uses are enormous
- At-sensor radiance calibration must be improved
- Earth Science users must be given unmodified data (or given a means to recover reliable at-sensor radiance)
- Radiometric resolution could be improved